Measures in Support of Evolutionary Acquisition

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Authors:

Jim Marple, Software Productivity Consortium
Brad Clark, Software Engineering Institute
Cheryl Jones, Army Research and Development Center
David Zubrow, Software Engineering Institute

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Clark, Brad ;
Jones, Cheryl ;
Zubrow, David ;

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The intent of this paper is to identify what measures are necessary to aid an acquisition agency and a contractor when it's decided that a program should follow an evolutionary acquisition strategy. Evolutionary acquisition is a strategy that develops and deploys a core capability with the intent to field additional capabilities as stakeholder needs, expectations, constraints, and interfaces are better understood.

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1. Executive Summary

The intent of this paper is to identify what measures are necessary to aid an acquisition agency and a contractor when it's decided that a program should follow an *evolutionary acquisition strategy*. Evolutionary acquisition is a strategy that develops and deploys a core capability with the intent to field additional capabilities as stakeholder needs, expectations, constraints, and interfaces are better understood.

Accordingly, we have developed four essential measures for adopting an evolutionary acquisition strategy:

1. The amount of risk on the program

   The intent of evolutionary acquisition is to reduce the risk on the project. Unless this is measured, there is no quantitative way to know whether the risk has been reduced.

2. The requirements changes by stakeholder type.

   Evolutionary acquisition assumes that there is significant involvement by all of the stakeholders on the program. This should be measured.

3. The number of requirements added, deleted, and modified per block.

   As the system evolves, and additional blocks are delivered, it is important to understand how the initial requirements of the system have been modified as the system evolves.

4. The discrepancy reports against the architecture.

   It is important to know that the initial architecture will support the total evolution of the system.

We looked at reasons for evolutionary acquisition, and developed questions that might be asked by the project managers of a program that has decided to follow a evolutionary acquisition strategy to determine additional measures that will help the project manager of an evolutionary acquisition are discussed later in this paper.

2. Overview

The process used in the investigation of measures identified critical success factors for evolutionary acquisition. These factors came from two SEI-sponsored Office of the Secretary of Defense (OSD) workshops, and from interviews about evolutionary acquisition. These factors were mapped into a measurement framework taken from Practical Software and System Measurement (PSM) [PSM 00]. Using the PSM process, measures were identified to provide insight into these factors (Section 6) by selecting from the existing measures

- modifying the existing measures, or
- defining new measures.

In several cases, new measures were not required, proving that existing measures can often be adapted to aid in the management of an evolutionary acquisition.

Members of the Lockheed Martin Undersea Systems were interviewed for their experience in managing evolutionary acquisition and spiral development [Roper 00]. This Manassas, Virginia-based organization is rated at a Capability Maturity Model® for Software Level 5 and possesses a strong measurement program. The group's existing measurement program covers evolutionary acquisition and development, as well as other acquisition and development strategies. The issue is a matter of deciding to change the

emphasis of their measurement program instead of developing new measures. One measure that they use, which is not currently a part of the PSM measures, is risk. Risk is tracked over time to determine a trend. Their approach to defining and managing evolutionary projects is discussed later.

This paper will address the application of measures that are currently in practice, as well as potential new measures that will aid in the management of an evolutionary acquisition.

3. Evolutionary Acquisition Definition

Evolutionary acquisition is a strategy that develops and deploys a core capability with the intent to field additional capabilities as stakeholder needs, expectations, constraints, and interfaces are better understood. Future capabilities are deployed in steps called "blocks" as shown in Figure 1 [Ferguson 00]. Future requirements to existing system capabilities come from end-user experience, emerging new technologies (e.g. Science and Technology activities), and support for new operational capabilities.

> "Evolutionary acquisition is an approach that fields an operationally useful and supportable capability in as short a time as possible. This approach is particularly useful if software is a key component of the system, and the software is required for the system to achieve its intended mission. Evolutionary acquisition delivers an initial capability with the explicit intent of delivering improved or updated capability in the future... Block 1 provides the initial deployment capability (a usable increment of capability called for in the Operational Requirements Document)." [DOD5000.2 00]

One of the basic benefits of evolutionary acquisition is that a user's hands-on experience with the system generates potential new capabilities and requirements. It is interesting to note that due to the block overlap shown in Figure 1, feedback and perhaps new requirements learned from using the deployed system will not be implemented until two blocks (at the earliest) after the identification. This could be remedied if there was time between the deployment of one block and the planning of the next block, if the appropriate contract mechanisms were in place.

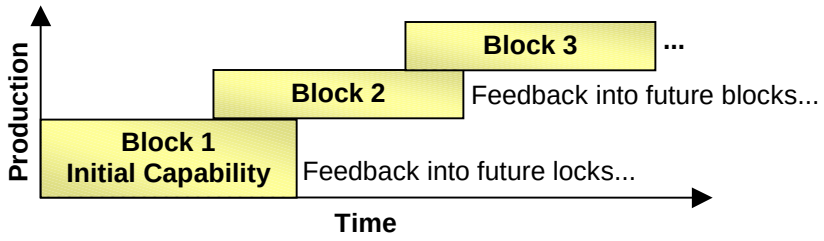


Figure 1: Evolutionary Block Increment Approach

An important requirement for specifying measures is to understand the criteria and issues for establishing an acquisition as evolutionary. The issues, upon which recommendations for measurement are based, cannot be identified until this acquisition approach is understood. A definition was developed in a SEI-sponsored OSD workshop held in September 2000. The workshop attempted to identify attributes of evolutionary acquisition.

A discussion group at the workshop focused on the definition of evolutionary acquisition. The table below summarizes their findings by comparing an evolutionary to an incremental acquisition strategy. [Place 00]

Evolutionary Acquisition	Incremental Acquisition
Definition: Evolutionary acquisition is an acquisition approach that deploys a core capability and incrementally inserts additional capabilities, as requirements are refined.	**Definition:** Incremental acquisition is an acquisition approach that deploys a full capability that is incrementally fielded based upon firm requirements for each block.
Attribute 1: Multiple deployments accommodating evolving requirements. - This is driven by opportunistic technology insertion, resolution of the many unknowns that exist with large complex systems, evolving threats, and the user's understanding of delivered capabilities. - There is variability in the degree of flexibility and time phasing of the deployments.	**Attribute 1:** Requirements for multiple deployments are strictly defined. - This is driven by few unknowns, a defined threat, planned technology insertion, and the user's understanding of the final capabilities. - The variability is in the time phasing of the increments.
Attribute 2: Acquisition is risk driven. - This captures the intent to define blocks based on risk reduction and having risks define the content of blocks. - There is variability in the number of blocks.	**Attribute 2:** Acquisition is requirements driven. - This captures the concept that capabilities for each increment are defined. - The variability is the number of increments.
Attribute 3: Stakeholders are involved in the decision point at the end of each block. - The decisions are the satisfaction of completion criteria for an block and the decision to "field" or "not field" the developed system. - The variability is who the stakeholders are and the decision criteria (risk, funding, capability, etc.)	**Attribute 3:** Stakeholders are involved in the decision point at the end of each increment. - The decision is whether to "field" or "not field" the developed system. The completion criteria are established with the pre-allocation of requirements. - The variability is who the stakeholders are and the decision criteria (risk, funding, satisfaction of requirements, etc.)

Evolutionary Acquisition	Incremental Acquisition
Attribute 4: Emphasis is on total life cycle activities. - All life cycle activities are planned for each block and the planning occurs for each block throughout system development. - The variability is in the amount of change to operational procedures, training, testing, maintenance support, re-certification, human interface, etc.	**Attribute 4:** Emphasis is on total life cycle activities. - All increments are preplanned and the life cycle activities must be planned for each increment. - The variability is in the change to testing, support, training, etc.

3.1 The Role of High Level Requirements

One approach to looking at role of requirements in evolutionary acquisition requirements is to look at the Operations Requirements Document (ORD). [Ferguson 00] The ORD defines overall requirements at Milestone 0. These requirements described the vision and ultimate objectives of the system. It includes a full definition of full capability, as well as a firm definition of requirements to be satisfied by each block, including the Initial Operational Capability for each block. The acquisition strategy shall define each block of capability and how it will be funded, developed, tested, produced, and operationally supported. [DOD5000.2 00, Sec 2.2.1.2.3]

The detailed requirements become known over time based on the threat, strategy, available capability, and available technology. [Ferguson 00]

ORDs contain eight or fewer key-performance parameters (KPP) [Ferguson 00]. KPPs are characterized by describing required capabilities, warfighting capabilities, and achievable and realistic success criteria (explainable by analysts). ORDs need to specify threshold values (minimum acceptable value) and objective values (desired value) for use in design and acceptance criteria. One required KPP will always be “Interoperability.” [DOD5000.2 00, Sec 2.1.1]

Other important attributes of the evolutionary acquisition strategy are that it may span many years, meet unforeseen threats, and must have a robust architecture capable of adapting to new emerging technologies. If the ORD cannot be met, either because of changes in the environment (such as threat changes) or because of significant changes in the technology, the program must be able to be terminated based on impracticality without consequences to careers or developer reputation.

The Lockheed Martin organization in Manassas, Virginia [Roper 00] has developed a slightly different model of evolutionary development. In their model, a set of System requirements is developed. These system requirements are allocated to a set of deliveries (blocks). A block is defined to be a deliverable that can be used in the field. At the beginning of each block, the block’s system requirements are allocated to software, hardware, and refined to the level where the design of this block can be accomplished. They have defined a new review that takes place at the end of each block. At this review, the stakeholders accept the current block, and the detailed requirements for the next block are reviewed and agreed to. This version of evolutionary development has some distinct advantages

- Since the total system requirements are known, the initial architecture is designed knowing the full set of system requirements, and will have a high probability of not having significant modifications for the life of the program.

- As each block goes through the design phase, the requirement of the future blocks can be used as constraints on the current design.
- The other life cycle components will be more stable, because the overall system requirements are well defined.

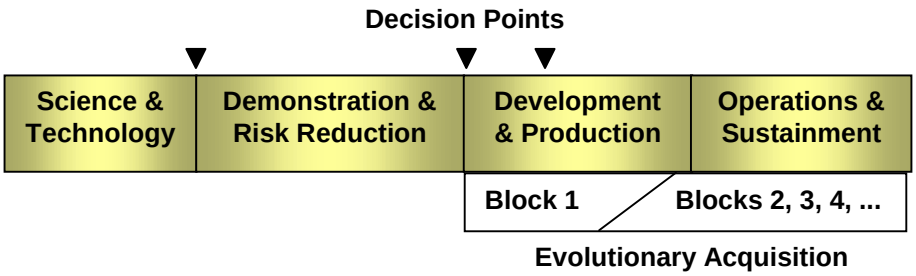
4. DoD Policy on Evolutionary Acquisition

The DoD is advocating a new acquisition approach in the updated 5,000 series of policies. This new approach has the goals of reducing cost and cycle time while delivering improved performance. Seven key focus areas were identified that would contribute to these objectives implement time-phased requirements and evolutionary acquisition

- strengthen the focus on modular, open-systems design
- strengthen implementation of supporting tools
- integrate test and evaluation
- enhance management of interoperability and system-of-systems issues
- integrate acquisition and logistics
- further streamline the acquisition process

The proposed new acquisition strategy, evolutionary acquisition, is shown in the Figure 2 below. In the Science and Technology (S&T) phase, new ideas and technology are started and matured. The Demonstration and Risk Reduction phase looks at alternatives, prototyping solutions, maturing technology, and evolving requirements. At the end of this phase, a commitment to an acquisition program is made based on initial user requirements, usefulness, mature technology currently available, and affordability of the system. An evolutionary acquisition program is then commenced that is committed to funding the first delivery at a reduced cost compared to the total program, with a shorter cycle time, and that produces a usable increment of capability.

Figure 2: Acquisition Life Cycle



This paper recommends an initial set of measures for use during the evolutionary acquisition phase of procurement. These measures are based on the issues a program executive officer will face in an evolutionary acquisition environment. This paper proceeds by first attempting to define what establishes an acquisition strategy as evolutionary. With this foundation, the critical success factors for evolutionary acquisition are identified. The issues and questions a program manager might have concerning these success factors are discussed. Measurement categories and measures are identified that support insight into the program manager's concerns. Finally, the rationale is provided for how each recommended measure supports insight into the evolutionary acquisition approach.

The evolutionary acquisition strategy implies evolutionary development of requirements, i.e. all of the detailed implementation requirements are not known. Insisting on specifying all of the detailed

requirements before acquisition commences leads to the traditional acquisition strategies, e.g. waterfall or incremental.

5. Evolutionary Acquisition Specific Issues

Several critical success factors were identified in the February [Hansen 00] and September [Workshop 00] of 2000 workshops sponsored by the Center for Software Engineering and the SEI. They are risk management, a trusting culture, involved stakeholders, technology readiness, flexible requirements, schedule, system breakage, and impact to life cycle support activities. For the purposes of defining measures, these critical success factors are the specific evolutionary acquisition issues that will be used to determine the candidate measures.

5.1 Risk Management

Evolutionary and spiral approaches to acquisition and development are intended to mitigate risk. Risk management should be used as an essential element for managing evolutionary acquisition. The ability to measure and track risk evolution over time is critical to the success of the program.

Understanding that difficult technical risks can break system and software architectures, the highest risks should be identified and resolved first.

This implies the need for an architecture that is well understood and accommodates risk mitigation plans. As the program progresses, there should be a steadily decreasing exposure to risk and the architecture should remain stable. Some of this type of risk can be measured in the risk section, others of this type of risk would be measured in the system breakage section.

Possible questions

- What are the high exposure risks and how many are there?
- How is risk exposure decreasing?
- Are risks migrating from block to block?

5.2 Trusting Culture and Involved Stakeholders

The acquirer, user, supplier, and maintainer are a team. A trusting culture cooperates in different areas of responsibility, embraces new ideas, and welcomes outsiders. In a trusting culture, technical risks can be identified without fear of career or contractual consequences. A risk or problem is addressed with constructive management action and not penalization. The “kill the messenger” syndrome must be avoided. The culture should foster a collaborative work environment where commitments are respected and new ideas or negative data are used to effectively manage the program.

The key to successful system development is collaboration between the DoD and the contractors. Anecdotal evidence suggests that when collaboration has occurred, systems have been developed in an economical and timely fashion.

Stakeholders should be involved in the establishment of the overall system requirements, and in the decision of which requirements will be implemented with every block. Stakeholders are defined as those groups that have a genuine interest in the successful deployment of a system, have a shared understanding of what the system will do, and agree to measures of success. Stakeholders come from groups representing technical or support activities, suppliers, customers, or end users.

In addition to the establishment of system requirements, evolutionary acquisition requires agreed-upon commitments by stakeholder groups to

- participate in the identification and resolution or issues and actions
- participate in block demonstrations and testing
- upgrade or modify life cycle factors that are affected

Possible questions

- What are effective principles and practices of integrated teams?
- Are there open communications among stakeholders?
- Who are the relevant stakeholders?
- What is the distribution of stakeholder organizations?
- Are different stakeholder responsibilities being met?
- What will be the stakeholder turnover within and between blocks?

5.3 Flexible Requirements

The evolutionary acquisition model must start with a set of known system-level requirements. The specific requirements for each block are developed as a result of the current risks on the project, the stakeholders understanding of the existing version of the system, and the readiness of the enabling technology. It is important to track requirements moving from block to block. This shifting of requirements to later blocks will indicate that there will be a cost increase and overall program slippage.

The deployment of a block creates a new baseline of requirements, (i.e. those that have been implemented.) New requirements will develop as blocks are deployed. As the system is used, the baseline requirements will be modified. There is a need to measure how the requirements change as the deployment of blocks progresses.

Possible questions

- How many requirements will be implemented in a block?
- How are requirements traced across blocks with the possibility of requirements being modified or deleted in later blocks?
- Will evolving requirements impact regression testing?

5.4 System Breakage

Breakage occurs when the latest block is deployed and the end-user says, “What happened to the old functionality?” It is important to understand at deployment time how the latest block of a product differs from earlier versions. Measures of system breakage would show the impact of the latest block on the products produced in previous blocks.

Possible questions

- Which block introduced the problem?
- Is the problem due to evolution of a requirement or new functionality?
- Is the existing architecture able to support the proposed new functionality and technology?

5.5 Technology Readiness

Acquisition of product blocks has to use mature technology. It needs to be demonstrable that the hardware is manufacturable, and neither the hardware nor software will need extraordinary, open-ended efforts during the development and manufacturing process phases. Experience has shown that projects are likely to fail unless the underlying technology has reached Level 6 on a scale of nine levels of “technology readiness”, as described below [Hansen 00, Sec. 2.3.4].

Level	Level Description
1	Basic principles observed and reported
2	Technology concept and/or application formulated.
3	Analytical and experimental critical function and/or characteristic proof of concept.
4	Component and/or breadboard validation in laboratory environment.
5	Component and/or breadboard validation in relevant environment.
6	System/subsystem model or prototype demonstration in a relevant environment.
7	System prototype demonstration in an operational environment.
8	Actual system completed and "mission" through test and demonstration.
9	Actual system “mission” through successful mission operations.

Possible questions

- Will appropriate test beds and laboratories be available when needed?
- What is the “readiness” rating for each technology component being considered for the next block?

5.6 Schedule

One of the primary drivers for evolutionary acquisition is to allow increased functionality to be placed in the field as rapidly as possible. As a part of the acquisition planning, the duration between blocks, objectives of each block, and the life cycle support for each block need to be defined. Since the detailed requirements for each block are not know ahead of time, the block duration, block objectives, and changes to life cycle support factors need to be agreed upon before the block development commences. The testing process is refined to include both regression testing of previous blocks, and the testing of new capabilities.

Possible questions

- How is the overall schedule for the project characterized?
- What is the duration of the block?
- How is test progress measured with a continuously growing system?
- Will the number of requirements be known for each block so that the number of implemented requirements can be tracked?
- What are the success criteria for each block?

5.7 Impact to Life Cycle Factors

Deciding on the functionality of the next block affects the other supporting life cycle resources. The actual impact on operational support (measured in terms of effort required or number of life cycle components that are changed) should be fully considered.. Operational support includes areas such as maintenance, supply, transportation, sustaining engineering, configuration and data management, manpower, training, environmental, health, safety, disposal, and security factors.[1]

Possible questions

- What is the cost and schedule allocated to life cycle factors in a block?
- When is the cost and schedule for the new block estimated?

[1] DOD Directive 5000.2, “2.3.2 Evolutionary Sustainment,” Final Draft.

- How are life cycle factors impacted for each block planned?

6. Selecting Measures

6.1 Mapping to PSM ICM structure

Specific measures for individual programs would be selected using the current PSM process of mapping specific program issues and risks to the common issue areas, measurement categories, and specific measures. With some exceptions, the measures for an evolutionary acquisition are not different than for other types of acquisitions. What is different are the attributes collected for that measure. There are some measures that would be applicable to evolutionary acquisition that are not in the current PSM structure. These new issues and categories are potential extensions to the existing PSM Issue-Category-Measure (ICM) structure.

Table 6.1 shows the PSM ICM structure with the recommended and candidate set of measures for use in providing program management insight into evolutionary acquisition. Some of the evolutionary acquisition issues mapped to multiple PSM Common Issues. In most cases the mapping was to existing PSM Common Issues and Categories. The measures are annotated to show their status with current PSM measures:

- * = New issue area, measurement category, or measure
- T = Tailoring of attributes of an existing PSM measure
- (Blank) = Existing PSM measures

Table 6.1				
Specific Issues	**Common Issue Area**	**Measurement Category**	**Recommended Measure**	**Other Candidate Measures**
Risk Management	Risk (*)	Risk (*)	Risk exposure (*)	- Number of risks /block (*) - Number of risks identified against a critical technology component (*) - Risk Carryover from previous block (*)
Flexibile Requirements	Product Size and Stability	Functional Size and Stability	Number of Requirements Added, Deleted & Modified per block.	- Requirements allocated by block. - Ratio of requirements satisfied in a block to total system requirements (T) - Number of allocated block requirements deferred to later blocks (T) - Number of baseline requirements changed. - Number of system requirements. - Requirements changes by stakeholder type (T)
Trusting Culture and Involved Stakeholders	Product Size and Stability	Collaborative Culture (*)	Requirement Changes by Stakeholder Type (T)	- Documented commitments by relevant stakeholders (*) - Documentation and resolution of issues, and action items by stakeholder (*) - Participation by stakeholders in demonstrations or testing (*) - Alignment of project performance with projected stakeholder needs, objectives, and requirements (*)
Technology Readiness	Resources and Cost	Enviroment Availability	N/A	- Availability of appropriate test beds (T)

Table 6.1				
Specific Issues	**Common Issue Area**	**Measurement Category**	**Recommended Measure**	**Other Candidate Measures**
Flexible Requirements	Schedule and Progress	Milestone Performance	N/A	- Inter-block milestones and changes in block schedule (T) - Block deployment milestones
		Incremental Capability	N/A	Build Component – function
		Work Unit Progress	N/A	Test case status
System breakage	Product Quality	Defects	Discrepancy Reports Against Architecture (T)	- Percentage of unchanged test cases (from previous block) (T) - Discrepancy reports against previously delivered functionality (T) - Tracking the amount of rework from one block to the next (T)
Impact to Life Cycle Factors	Product Quality	Life Cycle Impacts (*)	N/A	- Impact of newly allocated requirements to a block on the change of other life cycle components (i.e. training, security, etc.) (*) - Impact of discrepancy fixes on other life cycle components (i.e. training, security, etc.) (*) - Updates to plans for the implementation of life cycle components (*)

Table 6.1				
Specific Issues	**Common Issue Area**	**Measurement Category**	**Recommended Measure**	**Other Candidate Measures**
Technology Readiness	Technical Adequacy	Technology Impacts	N/A	Changes in the technology readiness levels (*)

Based on the critical success criteria, Table 6.2 identifies the rationale for selecting a specific measure for a specific program.

Table 6.2

Specific Issues	Candidate Measures	Rationale	Collection Interval with Success Guidelines
Flexible Requirements	1. Requirements allocated by block.	- Represents the work to be done for a block. The numbers of actual requirements are tracked against the number planned for a block. Trends in the number of requirements allocated to blocks are tracked over time.	- Tracked per block and for life the of program. The desire is to establish an average number of requirements implemented per block.
	2. Ratio of requirements satisfied in a block to total system requirements.	- Shows growth of capability of the system to eventually meet full system capability.	- Long term tracking. The desire is for a steadily increasing growth in system capability
	3. Number of requirements added, deleted & modified per block.	- Shows the volatility of requirements allocated to a block causing unplanned rework which could slip schedule.	- Tracked per block. The desire is for low change in requirements per block.

Table 6.2

Specific Issues	Candidate Measures	Rationale	Collection Interval with Success Guidelines
	4. Number of allocated block requirements deferred to later blocks.	- This measure would detect slipping new system capability into the future. Slipping functionality indicates that the agreed-to block requirements were unrealistic. This possibly means the allocation-decision process may not be effective. Slippage may also mean an overall increase in system life cycle cost.	- Tracked per block. The desire is for low slippage of requirements to future blocks.
Flexible Requirements (cont.)	5. Number of baseline requirements changed.	- This measures the rework necessary on previously implemented requirements that were changed due to deployment of blocks with conflicting interoperability needs. This measure provides the basis for planning requirements volatility.	- Tracked per block and for life of program. The desire is for low change in the requirements baseline.
	6. Number of system requirements.	- The system requirements are the foundation from which each block's requirements are derived. A growth or change in the capability of the system will change the total number of requirements to be implemented and the ratio of implemented requirements to system requirements.	Tracked for the life of program. This measure is used to normalize the ratio and trend of implemented requirements.

Table 6.2

Specific Issues	Candidate Measures	Rationale	Collection Interval with Success Guidelines
Risk Management	1. Risk exposure	- Risk exposure (amount of risk on the project) is a measure to determine if the Spiral development process is effectively reducing the risk on the project.	- Tracked long term. The desire is to have decreasing exposure.
	2. Number of risks per block	- This measure will show how the risks on each block are changing over time.	- Long term tracking. The desire is to decrease the numbers of risks.
	3. Number of risks identified against a critical technology component	- This measure is critical if there are significant technology risks on the project.	- Tracked per block with high risk components dropped from the development.
	4. Risk carryover from previous block	- Carryover is a way of measuring the effectiveness of the risk mitigation strategies that are planned and executed in each block of the program.	- Tracked per block. The desire is to have low numbers of risks transfer into new block developments.
Technology Readiness	1. Changes in the technology readiness levels (section 4.3) for system components	- Components based on technology that is not mature can delay the completion of a block. Components incorporated in previous blocks may continue to mature which may require their replacement.	- Long term tracking of components across blocks. The desire is to observe increasing technology readiness of components
	2. Availability of one-of-a-kind test beds (T)	- Unavailable facilities needed for integration and testing can delay the completion of a block.	- Tracked per block. The desire is to have as close to 100% availability as possible.

Table 6.2

Specific Issues	Candidate Measures	Rationale	Collection Interval with Success Guidelines
Involved Stakeholders and Trusting Culture	1. Documented commitments by relevant stakeholders	These two critical success factors are correlated, i.e. involved stakeholders implies a trusting culture. - The numbers and types of commitments by stakeholders are used for block planning.	- Tracked per block. The desired outcome is full satisfaction of commitments by stakeholder groups.
	2. Documentation and resolution of issues, and action items by stakeholder.	- Measures team cooperation and interaction.	- Tracked per block. The desire is to have input from all stakeholder groups.
	3. Participation by stakeholders in demonstrations or testing	- This measure shows there will be no "surprises" for stakeholders when the block is released	- Tracked per block. The desire is for comments or change requests to be submitted by all stakeholders.
	4. Alignment of project performance with projected stakeholder needs, objectives, and requirements.	- This measure shows the cumulative satisfaction of stakeholder needs with the block being developed	- Long term tracking across all block deployments. The desire is an increasing list of satisfied stakeholder requirements.
	5. Requirements changes by stakeholder type	- This may indicate the degree of incorporation of different stakeholder groups.	- Long term tracking. The desire is that no one group is excluded from the requirements allocation decision process for each build.

Table 6.2

Specific Issues	Candidate Measures	Rationale	Collection Interval with Success Guidelines
Schedule	1. Block deployment milestones.	- This measure shows the number of planned blocks and the duration of the overall program.	- Long term tracking. The desire is to observe on-time deployment of the planned blocks.
	2. Inter-block milestones and changes in block schedule	- This measure is intended to show the impact of inter-block dependencies. If there is a change in block n milestones, how does this impact the milestones in future blocks? This will be critical if there is overlap between the schedules of multiple blocks.	- Long term tracking. The desire is to observe little ripple effect between blocks because of milestone slippage.
	3. Build Component – function	- This measures the progress of functionality being implemented in a specific build.	- Tracked per build. The desire is to see actual meet planned implementation of functionality.
	4. Test case status	- Measure the progress of successful completion of testing.	- Tracked per build. The desire is to see progress that indicates the completion of testing to make the build completion date.

Table 6.2

Specific Issues	Candidate Measures	Rationale	Collection Interval with Success Guidelines
System Breakage	1. Percentage of unchanged test cases (from previous blocks)	- This measure would show the number of changes to regression tests as a result of the new block. It is an indirect measure of the stability of the previously delivered functionality	- Tracked per build. The desire is to see little change.
	2. Discrepancy reports against previously delivered functionality	- This would measure how the new functionality has impacted the functionality (or uncovered problems with the functionality) of previous blocks	- Tracked per build and for the long term. The desire is to see minimal breakage in previously delivered functionality.
	3. Tracking the amount of rework from one block to the next	- This is a measure or the cost/effort impact of system breakage	- Tracked per build and for the long term. The desire is to see minimal rework caused by system breakage.
	4. Discrepancy reports against architecture	- This is a measure of the "robustness" of the original architecture.	- Long term tracking. The desire is to observe few discrepancies concerning the architecture.

Table 6.2

Specific Issues	Candidate Measures	Rationale	Collection Interval with Success Guidelines
Impact to Life Cycle Factors	1. Impact of newly allocated requirements to a block on the change of other life cycle components (impact could be cost or number of affected components)	- This measure will show the impact of implementing additional requirements in a future build	- Track long term and per block. The desired result is a stable, average life cycle cost of implementing new requirements.
	2. Impact of discrepancy fixes on other life cycle components (i.e. training, security, etc.)	- This measure will show the impact of fixing a discrepancy in one block on the life cycle components of other blocks (both delivered and future)	- Track long term. The desired result is to observe a minimal cost to the rest of the system in fixing descrepancies within a block.
	3. Updates to plans for the implementation of life cycle components	- As each block is defined in detail, this would measure how the detailed planning of block n impacts the life cycle planning of both block n, and all other (past & future) blocks	- Track long term. This information can be used in planning the amount of effort required to keep plans updated.

7. Conclusion

Evolutionary acquisition has the goal of reducing cost and cycle time per deployment while delivering improved performance. Cost and cycle time reduction is achieved with the development and deployment of small blocks of functionality. Improved performance is achieved by using risk reduction strategies and stakeholder involvement in the definition and building of the blocks of functionality.

Cost and cycle time are traditionally measured and reported in any acquisition strategy. The emphasis on measuring risk and stakeholder involvement provide important, new insights in managing an evolutionary acquisition project. Important challenges to the evolutionary acquisition approach are:

- avoiding closed-ended solutions
- trading off requirements for cost and schedule in a block delivery
- using risk to set development priorities

8. Recommendations

There are two major recommendations.

1. Select an organization or organizations to pilot the recommended measures. In order to pilot the measures, it will be necessary that the organization currently is doing the activity that is being measured. For example, in order to pilot the risk amount measure, the organization should have a defined risk analysis process. If possible, we should look for organizations that may have already used a similar measure.
2. Develop a recommended update to the PSM measurement common issues, categories, and measurement specification tables. This should be done to all of the measures that appear in table 6.1. This task would be to develop a recommended update the version 4.0 PSM common issues, categories, and measurement specification tables, and present this update to the PSM organization for potential incorporation into the current PSM materials.

Acronyms

ARDEC	Army Research and Development Center
CMM	Capability Maturity Model
DOD	Department of Defense
ICM	Issue-Category-Measure
IOC	Initial Operational Capability
KPP	Key Performance Parameters
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
PSM	Practical Software and Systems Measurement
SDM	Spiral Development Model
SEI	Software Engineering Institute
S&T	Science and Technology
SPC	Software Productivity Consortium

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